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(71) Applicant: SHARP KABUSHIKI KAISHA [JP/JP]; 22-22, Nagaike-cho, Abeno-ku, Osaka-shi, Osaka 545-0013 (JP).

(72) Inventors: SUN, Shijun; 16900 S.E. 26th Drive, #47, Vancouver, WA 98683 (US). KEROFSKY, Louis Joseph; 1924 SW Mill Street Terrace, Portland, OR 97201 (US).

(74) Agent: TAKANO, Akichika; 9th Floor, Salute Bldg., 72, Yoshida-cho, Naka-ku, Yokohama-shi, Kanagawa 231-0041 (JP).

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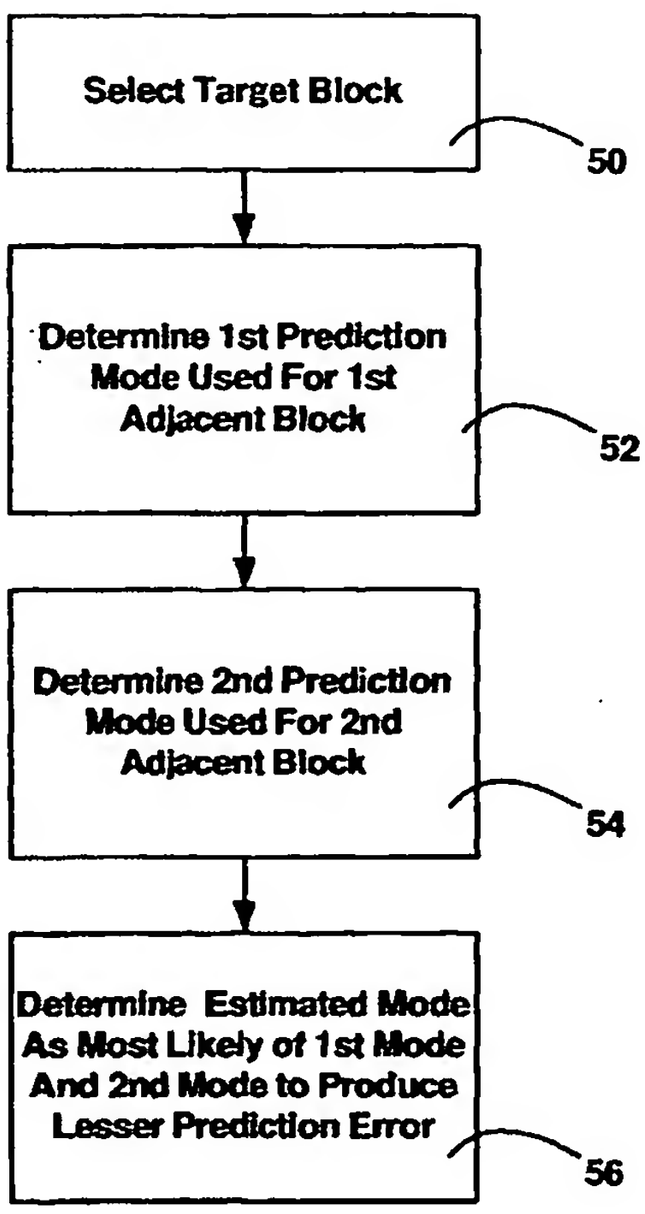
(54) Title: METHODS AND SYSTEMS FOR IMAGE INTRA-PREDICTION MODE ESTIMATION, COMMUNICATION, AND ORGANIZATION



(57) Abstract: Embodiments of the present invention relate to methods and systems for estimating a pixel prediction mode to be used in a video encoding or decoding process, for communicating pixel prediction modes between video encoders and decoders, and for ordering pixel intra-prediction modes.

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AMENDED CLAIMS

[received by the International Bureau on 27 November 2003 (27.11.2003);
original claims 1-13, 21-33 and 52-54 amended; remaining claims unchanged (15 pages)]

1. (amended) A method for estimating a pixel intra-prediction mode, said method comprising:

   a. selecting a target block for prediction mode estimation;

   b. determining a first prediction mode that has been used for a first adjacent block, said first adjacent block being adjacent to said target block;

   c. determining a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said target block;

   d. determining an estimated prediction mode for said target block from among said first prediction mode and said second prediction mode.

2. (amended) A method as described in claim 1 wherein said pixel intra-prediction mode includes a horizontal prediction mode.

3. (amended) A method as described in claim 1 wherein said pixel intra-prediction mode includes a vertical prediction mode.

4. (amended) A method as described in claim 1 wherein said pixel intra-prediction mode includes a DC prediction mode.

5. (amended) A method for estimating a pixel intra-prediction mode, said method comprising:

   a. ordering a set of potential prediction modes by associating a numerical value with each prediction mode;

   b. selecting a target block for prediction mode estimation;

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c. determining a first prediction mode that has been used for a first adjacent block, said first adjacent block being adjacent to said target block;

d. determining a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said target block;

e. determining a lesser prediction mode among said first prediction mode and said second prediction mode, wherein said lesser prediction mode is the prediction mode associated with the lesser value; and

f. using said lesser prediction mode as an estimated pixel prediction mode.

6. (amended) A method as described in claim 5 wherein said set of potential prediction modes comprises a horizontal prediction mode.

7. (amended) A method as described in claim 5 wherein said set of potential prediction modes comprises a vertical prediction mode.

8. (amended) A method as described in claim 5 wherein said set of potential prediction modes comprises a DC prediction mode.

9. (amended) A method as described in claim 5 wherein said set of potential prediction modes comprises:

a. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said first subset; and

c. a DC prediction mode.

10. (amended) A method for estimating a pixel intra-prediction mode:

a. ordering a set of potential prediction modes by associating a numerical value with each prediction mode;

b. selecting a target block for prediction mode estimation;

c. determining a first prediction mode that has been used for a first adjacent block, said first adjacent block being adjacent to said target block;

d. determining a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said target block;

e. designating a DC prediction mode as an estimated prediction mode if any of said adjacent prediction modes is unavailable;

f. determining a lesser prediction mode among said first prediction mode and said second prediction mode, wherein said lesser prediction mode is the prediction mode associated with the lesser value; and

g. using said lesser prediction mode as an estimated pixel prediction mode.

11. (amended) An apparatus for estimating a pixel prediction mode, said apparatus comprising:

a. a memory for storing an ordered set of potential prediction modes;

b. a selector for selecting a target block for prediction mode estimation;

c. a first determiner for determining a first prediction mode that has been used for a first adjacent block, said first adjacent block being adjacent to said target block;

d. a second determiner for determining a second prediction mode that has

been used to predict a second adjacent block, said second adjacent block being adjacent to said target block;

e. an estimator for estimating an estimated prediction mode for said target block from among said first prediction mode and said second prediction mode.

12. (amended) A computer-readable medium comprising instructions for estimating a pixel prediction mode, said instructions comprising the acts of:

a. selecting a target block for prediction mode estimation;

b. determining a first prediction mode that has been used for a first adjacent block, said first adjacent block being adjacent to said target block;

c. determining a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said target block;

d. determining an estimated prediction mode for said target block from among said first prediction mode and said second prediction mode.

13. (amended) A computer data signal embodied in an electronic transmission, said signal having the function of estimating a pixel prediction mode, said signal comprising instructions for completing the acts of:

a. selecting a target block for prediction mode estimation;

b. determining a first prediction mode that has been used for a first adjacent block, said first adjacent block being adjacent to said target block;

c. determining a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said

target block;

d. determining an estimated prediction mode for said target block from among said first prediction mode and said second prediction mode.

14. A method for modifying an ordered set of spatial pixel prediction modes, said method comprising:

a. establishing an ordered set of pixel prediction modes;

b. determining an estimated prediction mode;

c. modifying said ordered set by placing said estimated mode ahead of the order of said ordered set.

15. A method as described in claim 14 wherein said ordered set is ordered by likelihood of producing a reduced prediction error.

16. A method as described in claim 14 wherein said estimated prediction mode is included within said ordered set.

17. A method as described in claim 14 wherein said ordered set has an order that is independent of adjacent block data.

18. A method as described in claim 14 wherein said estimated prediction mode is determined with reference to adjacent block data.

19. A method as described in claim 14 wherein said estimated prediction mode is communicated to a decoder independently of said ordered set.

20. A method as described in claim 14 wherein at least a portion of the modes in said ordered set are in an order as follows:

a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

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b. the other mode of said axis subset;

c. a DC prediction mode;

d. a Diagonal Down Left prediction mo

21. (amended) A method for communicating a pixel ediction mode to a decoder, said method comprising:

a. preparing a set of pixel prediction mo s at an encoder and a decoder;

b. determining an estimated pixel predi n mode at said encoder and said decoder, said estimated mode being member of said set;

c. determining an actual prediction mo at said encoder, said actual prediction mode being a member of said

d. comparing said estimated mode to sa actual mode;

e. transmitting a first instruction, from id encoder to said decoder, to use said estimated mode; and

f. transmitting a second instruction, fr said encoder to said decoder, to use another mode in said set other than s d estimated mode.

22. (amended) A method as described in claim 21 v ein transmitting said first instruction when said estimated mode is substa ly similar to said actual mode and transmitting said second instruction when s estimated mode is not substantially similar to said actual mode.

23. (amended) A method as described in claim 21 v ein said another mode is said actual mode.

24. (amended) A method for identifying a pixel pre tion mode at a decoder, said method comprising:

a. preparing a set of pixel prediction modes;

b. identifying an estimated pixel prediction mode, said estimated mode being a member of said set;

c. identifying an actual prediction mode, said actual prediction mode being a member of said set;

d. being signaled with a first instruction to use said estimated mode; and

e. being signaled with a second instruction to use another mode in said set other than said estimated mode.

25. (amended) A method as described in claim 24 wherein being signaled said first instruction when said estimated mode is substantially similar to said actual mode and being signaled said second instruction when said estimated mode is not substantially similar to said actual mode.

26. (amended) A method as described in claim 24 wherein said another mode is said actual mode.

27. (amended) An apparatus for communicating a pixel prediction mode comprising:

a. means for preparing a set of potential prediction modes by associating a numerical value with each prediction mode such that associating the smallest numerical value with a vertical prediction mode, associating the second smallest numerical value with a horizontal prediction mode, associating the third smallest numerical value with a DC prediction mode and associating the other numerical values with the other prediction modes;

b. means for selecting a target block for prediction mode estimation;

c. means for determining a first prediction mode that has been used to predict a first adjacent block, said first adjacent block being adjacent to said target block;

d. means for determining a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said target block;

e. means for determining an estimated prediction mode among said first prediction mode and said second prediction mode, wherein said estimated prediction mode is the prediction mode associated with the lesser numerical value;

f. means for determining an actual prediction mode;

g. means for instructing a decoder to use said estimated prediction mode; and

h. means for instructing a decoder to use said actual prediction mode.

28. (amended) An apparatus for decoding a pixel prediction mode comprising:

a. means for preparing a set of potential prediction modes by associating a numerical value with each prediction mode such that associating the smallest numerical value with a vertical prediction mode, associating the second smallest numerical value with a horizontal prediction mode, associating the third smallest numerical value with a DC prediction mode and associating the other numerical values with the other prediction modes;

b. means for selecting a target block for prediction mode estimation;

c. means for determining a first prediction mode that has been used to predict a first adjacent block, said first adjacent block being adjacent to said target block;

d. means for determining a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said target block;

e. means for identifying an estimated prediction mode among said first prediction mode and said second prediction mode, wherein said estimated prediction mode is the prediction mode associated with the lesser numerical value;

f. means for identifying an actual prediction mode;

g. means for being instructed to use said estimated prediction mode; and

h. means for begin instructed to use an actual prediction mode.

29. (amended) An apparatus for generating a signal indicating a pixel prediction mode at an encoder comprising:

a. a memory for storing a set of pixel prediction modes;

b. an estimator for determining an estimated pixel prediction mode, said estimated mode being a member of said stored set;

c. a generator for generating a signal indicating an actual prediction mode;

d. wherein said generator generates a first signal to use said estimated pixel prediction mode as said actual prediction mode; and

e. wherein said generator generates a second signal to use other mode as

said actual prediction mode.

30. (amended) An apparatus for identifying a pixel prediction mode at a decoder comprising:

a. a memory for storing a set of pixel prediction modes;

b. an estimator for determining an estimated pixel prediction mode, said estimated mode being a member of said stored set;

c. wherein said decoder receiving a first signal to use said estimated pixel prediction mode as an actual prediction mode; and

d. wherein said decoder receiving a second signal to use other mode as said actual prediction mode.

31. (amended) A computer readable medium comprising instructions for communicating between a video encoder and a decoder, said instructions comprising the acts of:

a. preparing a set of pixel prediction modes at an encoder and a decoder;

b. determining an estimated pixel prediction mode at said encoder and said decoder, said estimated mode being a member of said set;

c. determining an actual prediction mode at said encoder, said actual prediction mode being a member of said set;

d. comparing said estimated mode to said actual mode;

e. transmitting a first instruction, from said encoder to said decoder, to use said estimated mode; and

f. transmitting a second instruction, from said encoder to said decoder, to use another mode in said set other than said estimated mode.

32. (amended) A computer readable medium comprising instructions for a decoder, said instructions comprising the acts of:

a. preparing a set of pixel prediction modes at a decoder;

b. identifying an estimated pixel prediction mode, said estimated mode being a member of said set;

c. identifying an actual prediction mode, said actual prediction mode being a member of said set;

d. being instructed a first instruction to use said estimated mode; and

e. being instructed a second instruction to use another mode in said set other than said estimated mode.

33. (amended) A computer data signal embodied in an electronic transmission, said signal having the function of communicating between a video encoder and decoder, said signal comprising instructions for:

a. establishing a set of pixel prediction modes at an encoder and a decoder;

b. determining an estimated pixel prediction mode at said encoder and said decoder, said estimated mode being a member of said set;

c. determining an actual prediction mode at said encoder, said actual prediction mode being a member of said set;

d. comparing said estimated mode to said actual mode;

e. transmitting a first instruction, from said encoder to said decoder, to use said estimated mode; and

f. transmitting a second instruction, from said encoder to said decoder, to

use another mode in said set other than said estimated mode.

34. A method for ordering a set of spatial pixel intra-prediction modes, said method comprising:

a. selecting a set of pixel prediction modes; and

b. ordering said intra-prediction modes substantially according to their likelihood of providing a lesser prediction error.

35. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said axis subset.

36. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said axis subset; and

c. a DC prediction mode.

37. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

value associated with said best mode.

51. An apparatus for efficient communication of pixel intra-prediction modes, said apparatus comprising:

a. an ordered set of pixel prediction modes wherein said ordered set comprises prediction modes in order as follows:

i. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

ii. the other mode of said first subset;

iii. a DC prediction mode; and

iv. a Diagonal Down Left prediction mode.

52. (amended) An apparatus as described in claim 51 wherein further comprises:

a. means for selecting a target block for prediction mode estimation;

b. means for determining a first prediction mode that has been used to predict a first adjacent block, said first adjacent block being adjacent to said target block;

c. means for determining a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said target block; and

d. means for determining an estimated prediction mode as said DC prediction mode when at least one of said first prediction mode and said second prediction mode are not available.

53. (amended) A computer readable medium comprising instructions for communicating a pixel intra-prediction modes, said mode is included within an

ordered set where said ordered set comprising:

i. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

ii. the other mode of said first subset;

iii. a DC prediction mode;

iv. a Diagonal Down Left prediction mode;

v. one mode taken from a second subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

vi. another mode taken from said second subset;

vii. the remaining mode from said second subset;

viii. a vertical left prediction mode; and

ix. a horizontal up prediction mode.

54. (amended) A computer data signal embodied in an electronic transmission, said signal having the function of communicating a pixel intra-prediction modes, said mode is included within an ordered set where said ordered set comprising modes in the following order:

a. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said first subset;

c. a DC prediction mode;

d. a Diagonal Down Left prediction mode;

e. one mode taken from a second subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

f. another mode taken from said second subset;

g. the remaining mode from said second subset;

h. a vertical left prediction mode; and

i. a horizontal up prediction mode.

set are of increasing numerical value. Alternatively for example, the data table entries may include the following sets of data entries {1, 2, 3, 5, 7}; {0, 1, 2, 3, 4, 5, 6}; {0, 1, 3, 5, 6, 7, 8}, where each set is included in at least 25%, or 35%, or 50%, or 75%, or 90%, or more, of the cells. In this manner, the table will have significantly more predictability than known data table methods, which decreases memory requirements.

The predetermined manner of the ordering of the sets of data entries should be independent of the prediction modes of adjoining sets of pixels (e.g. macroblocks). It is to be understood that the data table may be "static" in nature or may be effectively dynamically generated, in whole or in part, when needed based upon patterns in the data. Accordingly, a mathematical equation or an algorithm may be used to determine the entries, which in this case the "table" could be created by such a technique. Accordingly, a "data table" as used herein is not merely restricted to a static table, but further includes such a set of values, however determined, that are used for such prediction.

Unfortunately, the substitution of the previous mode numbers with the new mode numbers (e.g., a substitution of numbers into the cells of known data tables), while perhaps an improvement, still results in a generally unordered set of data.

Estimating a Pixel Prediction Mode Based on Adjacent Block Data

In contrast to the generally unordered set of data shown, even with substitutions, the present inventors came to the further realization that the most likely prediction mode should be ordered first, the second most likely prediction mode ordered second, if desired, followed by the remaining modes in a predetermined manner. The predetermined manner should be independent of the prediction modes of adjoining macroblocks. The preferred

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order of the remaining modes [redacted]uld be in a decreasing likelihood of occurrence of the remaining modes (most likely [redacted]diction mode, and if desired, second most likely prediction mode).

Based on the intra pre[redacted]ion modes of block A and block B, as shown in Figure 1, the intra prediction mode orde[redacted]r block C may be defined as follows:

(1) If both block A [redacted]d block B are "outside" (e.g., not available), only DC prediction (mode 2) is permitt[redacted] therefore the intra prediction mode order for block C is {2}.

(2) If block A is "[redacted]ide" (e.g., not available) and block B is not "outside", only DC prediction (mode 2) [redacted] horizontal prediction (mode 0) are permitted for block C, therefore;

(i) if block B is 2, [redacted]ra prediction mode order for block C is {2, 0};

(ii) otherwise, intr[redacted]rediction mode order for block C is {0, 2}.

(3) If block A is n[redacted]outside" but block B is "outside", only DC prediction (mode 2) and vertical predicti[redacted](mode 1) are permitted for block C, therefore

(i) if block A is 2, [redacted]ra prediction mode order for block C is {2, 1};

(ii) otherwise, intr[redacted]rediction mode order for block C is {1, 2}.

(4) If neither block [redacted]nor block B is "outside",

(i) if the predictio[redacted]ode of block A is less than the prediction mode of block B, then intra prediction mode [redacted]er for block C is {intra prediction block mode A, intra prediction block mode B, othe[redacted]odes in ascending order};

(ii) if the predictio[redacted]ode of block A is greater than the prediction mode of block B, then intra prediction [redacted]de order for block C is {intra prediction block mode B,

intra prediction block mode A, other modes in ascending order};

(iii) if the prediction mode of block A equals the prediction mode of block B, then intra prediction mode order for block C is {intra prediction block mode A, other modes in ascending order}.

For example, if the prediction mode of block A is 3 and the prediction mode of block B is 1, then intra prediction mode order for block C is {1, 3, 0, 2, 4, 5, 6, 7, 8}. With the modes arranged in a generally decreasing likelihood (or increasing) of occurrence, then the automatic arrangement of the remaining modes of occurrence will still be generally arranged in the proper sequence. The ordering of the sequence from higher to lower probability increases the likelihood of the proper prediction toward the front. With entropy encoding this decreases the resulting encoded bit stream. Other arrangements may likewise be used.

Conceptually the aforementioned selection scheme is based upon the principle that if the prediction of block A is X and the prediction of block B is Y, then it is likely the prediction of block C is X or Y. The prediction for X and/or Y is located at the start of the list and the remaining modes are sequentially listed thereafter.

Stated another way, when the prediction modes of A and B are known (including the case that A or B or both are outside the slice) the most probable mode of C is given, namely, the minimum of the modes used for blocks A and B. If one of the blocks A or B is "outside" the most probable mode is equal to prediction mode 2. The ordering of prediction modes assigned to blocks C is therefore the most probable mode followed by the remaining modes in the ascending order.

Embodiments of the present invention may be described with reference to Figure 9. In these embodiments, a target block is selected 50 for prediction. A prediction mode used for prediction of a first adjacent block, which is immediately adjacent to said target block, is then determined 52. A prediction mode used for prediction of a second adjacent block, which is also adjacent to said target block is also determined 54. These adjacent block prediction modes are then examined 56 to determine which is more likely to produce a lesser prediction error.

In other embodiments of the present invention, as illustrated in Figure 10, a set of prediction modes is ordered 58 according to the modes' likelihood of producing a lesser prediction error. A target block is selected 60. The prediction mode used for a first adjacent block is determined 62 and the prediction mode used for a second adjacent block is also determined 64. These two prediction modes are then examined 66 to determine which occurs first in the ordered set of modes thereby corresponding to the mode with the higher likelihood of producing a lesser prediction error.

In further embodiments of the present invention, as illustrated in Figure 11, a set of prediction modes is ordered 68 by likelihood of producing a lesser prediction error. These modes in the ordered set are then associated 70 with numerical values such that modes with a higher likelihood of producing a lesser prediction error are associated with lower numerical values. The mode used to predict a first adjacent block is then determined 72 and the mode used to predict a second adjacent block is also determined 74. These adjacent block modes are then examined to determine which mode is associated with a lower numerical value. This mode is designated as the estimated mode for prediction of the target block.

In still further embodiments, as illustrated in Figure 12, a set of prediction modes is ordered 78 by likelihood of producing a lesser prediction error. These modes in the ordered set are then associated 80 with numerical values such that modes with a higher likelihood of producing a lesser prediction error are associated with lower numerical values. An attempt 82 is made to determine the mode used to predict a first adjacent block and an attempt 84 is made to determine the mode used to predict a second adjacent block. If the prediction mode used to predict the first adjacent block is not available 86, a default prediction mode, such as a DC prediction mode, may be designated 90 as an estimated prediction mode for the target block. Also, if the prediction mode used to predict the second adjacent block is not available 88, a default prediction mode, such as a DC prediction mode, may be designated 90 as an estimated prediction mode for the target block. When the adjacent block prediction modes are available, these adjacent block modes may be examined to determine which mode is associated with a lower numerical value. This mode is then designated 92 as the estimated mode for prediction of the target block.

Modification of Prediction Mode Order Based on Adjacent Block Data

In some embodiments of the present invention the prediction mode orders described above, which have been determined independently of the adjacent block data, may be modified with adjacent block data. Prediction mode estimates determined with reference to adjacent block data can be inserted into prediction mode orders to modify the orders to reflect the additional information obtained from adjacent block data.

In some of these embodiments, a prediction mode estimate, based on adjacent

block data, can be inserted directly into a prediction mode order set. Typically, the prediction mode estimate will be inserted or prepended at the front of the prediction mode order at the position of the mode most likely to produce a reduced prediction error. However, in some embodiments the estimate may be inserted at different positions in the mode order.

In some embodiments of the present invention, as shown in Figure 13, a prediction mode order is selected 102 wherein the prediction mode order elements may be arranged according to their likelihood of producing a lesser prediction error. In other words, the first element in the order represents the prediction mode most likely to yield a lesser prediction error, the next element in the order represents the prediction mode that is the next most likely to yield a lesser prediction error and so on to the last element in the order, which represents the prediction mode in the order that is least likely to yield a lesser prediction error.

A prediction mode estimate is also determined 104, as described above. This estimate is determined using adjacent block data. Generally, the estimate is the prediction mode used in one or more adjacent blocks that is likely to yield a lesser prediction error. However, the estimate may be determined in other ways. When sufficient adjacent block prediction mode data is not available, such as at an image edge or a slice boundary, a prediction mode for the target block may be estimated based on the lack of one or more adjacent blocks or their prediction mode data. In many cases, a DC prediction mode will be estimated when adjacent block data is limited or unavailable.

In some embodiments, once the estimated prediction mode is estimated, the estimated prediction mode may be placed 106 into the mode order as the mode most

likely to yield a lesser prediction error. In some embodiments, this will be the first mode in the order or the mode associated with the lowest numerical value.

In other embodiments, the estimated prediction mode may take precedence over the pre-selected mode order. In some of these embodiments, as illustrated in Figure 14, a pre-selected mode order is designated 110 at the encoder and the decoder. This order comprises a set of prediction modes arranged in order of likelihood of yielding a lesser prediction error or some other order. An estimated prediction mode is also determined 112 based on adjacent block data. This estimated prediction mode is determined at the encoder and the decoder according to the same algorithm or method. The encoder also determines the actual best prediction mode 114 for predicting a pixel based on motion vectors or other known techniques. The encoder may, then, compare 116 the actual best prediction mode to the estimated prediction mode to determine whether they are the same. If the estimated prediction mode is the same mode as the actual best prediction mode, the encoder may signal to the decoder that the estimated prediction mode is to be used 118. In some embodiments, this estimated prediction mode signal may be performed with a 1-bit flag to signify whether the estimated mode is to be used on not.

If the estimated prediction mode is not the actual best prediction mode, the encoder may signal to the decoder that another mode may be used 120. This may be performed by reference to the pre-established mode order. The encoder may determine which mode in the mode order is most equivalent to the actual best prediction mode and signal the decoder to use that mode.

When an ordered set of prediction modes is used, the set order may be rearranged once further data is obtained. For example, an ordered set of prediction modes may be re-

ordered when an estimated prediction mode is determined or when a best actual prediction mode is determined. In these cases, the modifying mode may be interjected into the ordered set, placed ahead of the ordered set or, in some cases, removed from the ordered set.

In some embodiments of the present invention, each mode in the mode order may be associated with a numerical value according to the order. In these embodiments, the numerical value associated with the mode to be used may be sent to the decoder to signal the decoder to use that prediction mode. In some of these embodiments, as illustrated in Figure 15, a mode order comprising 9 prediction modes may be selected 130. An estimated prediction mode based on adjacent block data, and which is one of the 9 modes in the order, may also be determined 132. A best prediction mode may also be determined 134 by motion vector methods or other methods. The best prediction mode may then be compared to the estimated prediction mode 136. If the estimated prediction mode is substantially the same as the best prediction mode, the decoder may be signaled with a 1-bit designator to use the estimated prediction mode, which is already identified at the decoder. If the estimated prediction mode is not equivalent to the best prediction mode, the estimated prediction mode is essentially eliminated from the mode order 140. This elimination may be performed by re-ordering the set, skipping the estimated mode in the order or by other means. The remaining order will effectively comprise 8 modes, which can be represented by a 3-bit designator. This 3-bit designator may be sent to the decoder 142 to designate which mode to use for prediction.

The terms and expressions employed in the foregoing specification are used therein as terms of description and not of limitation, and there is no intention in the use of

such terms and expressions of excluding equivalents of the features shown and described or portions thereof, it being recognized that the scope of the invention is defined and limited only by the claims that follow.

We claim:

CLAIMS

1. A method for estimating a pixel intra-prediction mode, said method comprising:

   a. selecting a target block for prediction mode estimation;

   b. determining a first prediction mode that has been used for a first adjacent block, said first adjacent block being adjacent to said target block;

   c. determining a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said target block;

   d. determining an estimated prediction mode for said target block from among said first prediction mode and said second prediction mode, wherein said estimated prediction mode is the prediction mode that is most likely to yield the least prediction error.

2. A method as described in claim 1 wherein said estimated pixel prediction mode is a DC prediction mode when at least one of said first prediction mode and said second prediction mode are not available.

3. A method as described in claim 1 wherein said estimated pixel prediction mode is a DC prediction mode when said first prediction mode and said second prediction mode are not available.

4. A method as described in claim 1 wherein said likelihood of yielding a lower prediction error is determined independent of the location of said target block.

5. A method for estimating a pixel intra-prediction mode that is more likely to result in a reduced prediction error, said method comprising:

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a. ordering a set of potential prediction modes by associating a numerical value with each prediction mode such that the modes most likely to yield a lower prediction error are associated with the lowest numbers;

b. selecting a target block for prediction mode estimation;

c. receiving a first prediction mode that has been used for a first adjacent block, said first adjacent block being adjacent to said target block;

d. receiving a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said target block;

e. determining a lesser prediction mode among said first prediction mode and said second prediction mode, wherein said lesser prediction mode is the prediction mode associated with the lesser value; and

f. using said lesser prediction mode as an estimated pixel prediction mode.

6. A method as described in claim 5 wherein said estimated pixel prediction mode is a DC prediction mode when at least one of said first prediction mode and said second prediction mode are not available.

7. A method as described in claim 5 wherein said estimated pixel prediction mode is a DC prediction mode when said first prediction mode and said second prediction mode are not available.

8. A method as described in claim 5 wherein said likelihood of yielding a lower prediction error is determined independent of the location of said target block.

9. A method as described in claim 5 wherein said set of potential prediction modes

comprises, in order of likelihood of yielding a lower prediction error:

a. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said first subset; and

c. a DC prediction mode.

10. A method for estimating a pixel intra-prediction mode that is more likely to result in a reduced prediction error, said method comprising:

a. ordering a set of potential prediction modes by associating a numerical value with each prediction mode such that the modes most likely to yield a lower prediction error are associated with the lowest numbers;

b. selecting a target block for prediction mode estimation;

c. attempting to determine a first prediction mode that has been used for a first adjacent block, said first adjacent block being adjacent to said target block;

d. attempting to determine a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said target block;

e. designating a DC prediction mode as an estimated prediction mode if any of said adjacent prediction modes is unavailable;

f. determining a lesser prediction mode among said first prediction mode and said second prediction mode, wherein said lesser prediction mode is the prediction mode associated with the lesser value; and

g. using said lesser prediction mode as an estimated pixel prediction

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mode.

11. An apparatus for estimating a pixel prediction mode, said apparatus comprising:

a. a memory for storing an ordered set of potential prediction modes ordered by their likelihood of yielding a lower prediction error;

b. a selector for selecting a target block for prediction mode estimation;

c. a first determiner for determining a first prediction mode that has been used for a first adjacent block, said first adjacent block being adjacent to said target block;

d. a second determiner for determining a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said target block;

e. an estimator for estimating an estimated prediction mode for said target block from among said first prediction mode and said second prediction mode, wherein said estimated prediction mode is the prediction mode that is most likely to yield the least prediction error as determined by the mode's order in said ordered set.

12. A computer-readable medium comprising instructions for estimating a pixel prediction mode, said instructions comprising the acts of:

a. selecting a target block for prediction mode estimation;

b. determining a first prediction mode that has been used for a first adjacent block, said first adjacent block being adjacent to said target block;

c. determining a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said

target block;

d. determining an estimated prediction mode for said target block from among said first prediction mode and said second prediction mode, wherein said estimated prediction mode is the prediction mode that is most likely to yield the least prediction error.

13. A computer data signal embodied in an electronic transmission, said signal having the function of estimating a pixel prediction mode, said signal comprising instructions for completing the acts of:

a. selecting a target block for prediction mode estimation;

b. determining a first prediction mode that has been used for a first adjacent block, said first adjacent block being adjacent to said target block;

c. determining a second prediction mode that has been used to predict a second adjacent block, said second adjacent block being adjacent to said target block;

d. determining an estimated prediction mode for said target block from among said first prediction mode and said second prediction mode, wherein said estimated prediction mode is the prediction mode that is most likely to yield the least prediction error.

14. A method for modifying an ordered set of spatial pixel prediction modes, said method comprising:

a. establishing an ordered set of pixel prediction modes;

b. determining an estimated prediction mode;

c. modifying said ordered set by placing said estimated mode ahead of

the order of said ordered set.

15. A method as described in claim 14 wherein said ordered set is ordered by likelihood of producing a reduced prediction error.

16. A method as described in claim 14 wherein said estimated prediction mode is included within said ordered set.

17. A method as described in claim 14 wherein said ordered set has an order that is independent of adjacent block data.

18. A method as described in claim 14 wherein said estimated prediction mode is determined with reference to adjacent block data.

19. A method as described in claim 14 wherein said estimated prediction mode is communicated to a decoder independently of said ordered set.

20. A method as described in claim 14 wherein at least a portion of the modes in said ordered set are in an order as follows:

a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said axis subset;

c. a DC prediction mode;

d. a Diagonal Down Left prediction mode.

21. A method for communicating a pixel prediction mode to a decoder, said method comprising:

a. establishing a set of pixel prediction modes at an encoder and a decoder;

b. determining an estimated pixel prediction mode at said encoder and

said decoder, said estimated mode being a member of said set;

c. determining a best prediction mode at said encoder, said best prediction mode being a member of said set;

d. comparing said estimated mode to said best mode;

e. transmitting a first instruction, from said encoder to said decoder, to use said estimated mode when said estimated mode is substantially similar to said best mode; and

f. transmitting a second instruction, from said encoder to said decoder, to use another mode in said set other than said estimated mode when said estimated mode is not substantially similar to said best mode.

22. A method as described in claim 21 wherein first instruction is a 1-bit designator.

23. A method as described in claim 21 wherein said second instruction is a 3-bit designator.

24. A method as described in claim 21 wherein said set of pixel prediction modes is ordered according to a likelihood of producing a lesser prediction error.

25. A method as described in claim 24 wherein each of said modes in said set is associated with a numerical value wherein a lower value is assigned according to a mode's likelihood of producing a lesser prediction error.

26. A method as described in claim 25 wherein said transmitting a second instruction comprises sending the numerical values associated with said best mode.

27. A method for communicating a pixel prediction mode to a decoder, said method comprising:

a. establishing an ordered set of pixel prediction modes at an encoder and

a decoder wherein said set is ordered by likelihood of producing a lesser prediction error;

b. determining an estimated pixel prediction mode at said encoder and said decoder wherein said estimated mode is determined with reference to adjacent block data and said estimated mode is a member of said set;

c. determining a best prediction mode at said encoder, said best mode being a member of said set;

d. comparing said estimated mode to said best mode;

e. transmitting a first instruction, from said encoder to said decoder, to use said estimated mode when said estimated mode is substantially similar to said best mode; and

f. communicating a second instruction, between said encoder and said decoder, to use another mode in said set other than said estimated mode when said estimated mode is not similar to said best mode.

28. A method as described in claim 27 wherein said another mode is said best mode.

29. A method as described in claim 27 wherein at least a portion of the modes in said ordered set are in an order as follows:

a. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said first subset;

c. a DC prediction mode; and

d. a Diagonal Down Left prediction mode.

30. A method for communicating a pixel prediction mode, said method comprising:

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a. ans for ordering a set of potential prediction modes by associating a nu ical value with each prediction mode such that the modes most lik o yield a lower prediction error are associated with the lowest nu ical values;

b. ans for selecting a target block for prediction mode estimation;

c. ans for determining a first prediction mode that has been used for a fir djacent block, said first adjacent block being adjacent to said target blo

d. ans for determining a second prediction mode that has been used to pre a second adjacent block, said second adjacent block being adjacent to target block;

e. ans for determining an estimated prediction mode among said first pre ion mode and said second prediction mode, wherein said estimated pre ion mode is the prediction mode associated with the lesser nu ical value;

f. ans for determining a best prediction mode;

g. ans for instructing a decoder to use said estimated prediction mode wh aid estimated prediction mode is substantially similar to said best pre ion mode; and

h. ans for instructing a decoder to use said best prediction mode when sa timated prediction mode is not substantially similar to said best pre ion mode.

31. An appara for communicating a pixel prediction mode to a decoder, said

apparatus comprising:

a. an encoder memory for storing a set of pixel prediction modes at an encoder;

b. a decoder memory for storing said set of pixel prediction modes at a decoder;

c. an encoder estimator for determining an estimated pixel prediction mode at said encoder, said estimated mode being a member of said stored set;

d. a decoder estimator for determining said estimated pixel prediction mode at said decoder;

e. a predictor for determining a best prediction mode at said encoder, said best prediction mode being a member of said set;

f. a transmitter for transmitting instructions between an encoder and a decoder;

g. wherein said transmitter transmits a first instruction, from said encoder to said decoder instructing said decoder to use said estimated mode when said estimated mode is substantially similar to said best mode; and

h. wherein said transmitter transmits a second instruction, from said encoder to said decoder, to use said best mode when said estimated mode is not substantially similar to said best mode.

32. A computer readable medium comprising instructions for communicating between a video encoder and a decoder, said instructions comprising the acts of:

a. establishing a set of pixel prediction modes at an encoder and a

decoder;

b. determining an estimated pixel prediction mode at said encoder and said decoder, said estimated mode being a member of said set;

c. determining a best prediction mode at said encoder, said best prediction mode being a member of said set;

d. comparing said estimated mode to said best mode;

e. transmitting a first instruction, from said encoder to said decoder, to use said estimated mode when said estimated mode is substantially similar to said best mode; and

f. transmitting a second instruction, from said encoder to said decoder, to use another mode in said set other than said estimated mode when said estimated mode is not substantially similar to said best mode.

33. A computer data signal embodied in an electronic transmission, said signal having the function of communicating between a video encoder and decoder, said signal comprising instructions for:

a. establishing a set of pixel prediction modes at an encoder and a decoder;

b. determining an estimated pixel prediction mode at said encoder and said decoder, said estimated mode being a member of said set;

c. determining a best prediction mode at said encoder, said best prediction mode being a member of said set;

d. comparing said estimated mode to said best mode;

e. transmitting a first instruction, from said encoder to said decoder, to

use said estimated mode when said estimated mode is substantially similar to said best mode; and

f. transmitting a second instruction, from said encoder to said decoder, to use another mode in said set other than said estimated mode when said estimated mode is not substantially similar to said best mode.

34. A method for ordering a set of spatial pixel intra-prediction modes, said method comprising:

a. selecting a set of pixel prediction modes; and

b. ordering said intra-prediction modes substantially according to their likelihood of providing a lesser prediction error.

35. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said axis subset.

36. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said axis subset; and

c. a DC prediction mode.

37. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

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a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said axis subset;

c. a DC prediction mode; and

d. a Diagonal Down Left prediction mode.

38. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said axis subset;

c. a DC prediction mode;

d. a Diagonal Down Left prediction mode; and

e. one mode taken from an angular subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode.

39. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said axis subset;

c. a DC prediction mode;

d. a Diagonal Down Left prediction mode;

e. one mode taken from an angular subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode; and

f. another mode taken from said angular subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode.

40. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said axis subset;

c. a DC prediction mode;

d. a Diagonal Down Left prediction mode;

e. one mode taken from an angular subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

f. another mode taken from said angular subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode; and

g. the remaining mode from said angular subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode.

41. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said axis subset;

c. a DC prediction mode;

d. a Diagonal Down Left prediction mode;

e. one mode taken from an angular subset consisting of a horizontal

down mode, a diagonal down right mode and a vertical left mode;

f. another mode taken from said angular subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

g. the remaining mode from said angular subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode; and

h. a vertical left prediction mode.

42. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said axis subset;

c. a DC prediction mode;

d. a Diagonal Down Left prediction mode;

e. one mode taken from an angular subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

f. another mode taken from said angular subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

g. the remaining mode from said angular subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

h. a vertical left prediction mode; and

i. a horizontal up prediction mode.

43. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the remaining mode from said first subset;

c. one mode taken from a second subset consisting of a DC prediction mode and a Diagonal Down Left prediction mode;

d. the remaining mode from said second subset;

e. one mode taken from a third subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

f. another mode taken from said third subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

g. the remaining mode from said third subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

h. one mode taken from a fourth subset consisting of a vertical left prediction mode and a horizontal up prediction mode; and

i. the remaining mode from said fourth subset.

44. A method as described in claim 34 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the remaining mode from said first subset;

c. one mode taken from a second subset consisting of a DC prediction mode, a Diagonal Down Right prediction mode and a Diagonal Down Left prediction mode; and

d. any of the modes remaining in said second subset and any modes in a third subset consisting of a horizontal down mode, vertical right mode, a vertical left mode and a horizontal up mode in any order.

45. A method for efficient communication of pixel intra-prediction modes, said method comprising:

a. selecting a set of pixel prediction modes;

b. ordering said set of prediction modes according to their likelihood of producing a lesser prediction error;

c. associating modes in said ordered set with increasing numerical values such that the mode most likely to produce a lesser prediction error is associated with the lowest numerical value and the next most likely mode for producing a lesser prediction error is associated with the next lower numerical value and so on throughout the set;

d. determining a best prediction mode for predicting a pixel, said mode being among said set;

e. indicating to a decoder to use said best mode using said numerical value associated with said best mode.

46. A method as described in claim 45 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from an axis subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said axis subset;

c. a DC prediction mode; and

d. a Diagonal Down Left prediction mode.

47. A method as described in claim 45 wherein said ordering comprises ordering at least a portion of the modes in said set in an order as follows:

a. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the remaining mode from said first subset;

c. one mode taken from a second subset consisting of a DC prediction mode and a Diagonal Down Left prediction mode;

d. the remaining mode from said second subset;

e. one mode taken from a third subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

f. another mode taken from said third subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

g. the remaining mode from said third subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

h. one mode taken from a fourth subset consisting of a vertical left prediction mode and a horizontal up prediction mode; and

i. the remaining mode from said fourth subset.

48. A method as described in claim 45 wherein said indicating is performed using entropy coding thereby reducing required bandwidth for the communication.

49. A method as described in claim 48 wherein said indicating is performed using variable-length coding thereby reducing required bandwidth for the communication.

50. A method for organizing a set of pixel intra-prediction modes for more efficient communication of said modes, said method comprising:

a. selecting a set of pixel prediction modes comprising a plurality of modes taken from the group consisting of: a vertical prediction mode, a horizontal prediction mode, a DC prediction mode, a diagonal down left prediction mode, a diagonal down right prediction mode, a horizontal up prediction mode, a horizontal down prediction mode, a vertical right prediction mode and a vertical left prediction mode;

b. ordering at least a portion of said modes in said set into an ordered set wherein said ordering comprises placing said modes in an order as follows

i. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

ii. the other mode of said first subset;

iii. a DC prediction mode; and

iv. a Diagonal Down Left prediction mode;

c. associating modes in said ordered set with increasing numerical values such that the mode most likely to produce a lesser prediction error is associated with the lowest numerical value and the next most likely mode for producing a lesser prediction error is associated with the nest lower numerical value and so on throughout the set;

d. determining a best prediction mode for predicting a pixel, said best mode being among said set;

e. indicating to a decoder to use said best mode using said numerical

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value associated with said best mode.

51. An apparatus for efficient communication of pixel intra-prediction modes, said apparatus comprising:

a. an ordered set of pixel prediction modes wherein said ordered set comprises prediction modes in order as follows:

i. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

ii. the other mode of said first subset;

iii. a DC prediction mode; and

iv. a Diagonal Down Left prediction mode.

52. An apparatus as described in claim 51 wherein said order further comprises, in order following said Diagonal Down Left prediction mode, the following modes:

i. one mode taken from a second subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

ii. another mode taken from said second subset;

iii. the remaining mode from said second subset;

iv. a vertical left prediction mode; and

v. a horizontal up prediction mode.

53. A computer readable medium comprising instructions for communicating an ordered set of pixel intra-prediction modes, said order comprising:

i. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

ii. the other mode of said first subset;

iii. a DC prediction mode;

iv. a Diagonal Down Left prediction mode;

v. one mode taken from a second subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

vi. another mode taken from said second subset;

vii. the remaining mode from said second subset;

viii. a vertical left prediction mode; and

ix. a horizontal up prediction mode.

54. A computer data signal embodied in an electronic transmission, said signal having the function of communicating an ordered set of pixel intra-prediction modes, said ordered set comprising modes in the following order:

a. one mode taken from a first subset consisting of a horizontal prediction mode and a vertical prediction mode;

b. the other mode of said first subset;

c. a DC prediction mode;

d. a Diagonal Down Left prediction mode;

e. one mode taken from a second subset consisting of a horizontal down mode, a diagonal down right mode and a vertical left mode;

f. another mode taken from said second subset;

g. the remaining mode from said second subset;

h. a vertical left prediction mode; and

i. a horizontal up prediction mode.

FIG.1

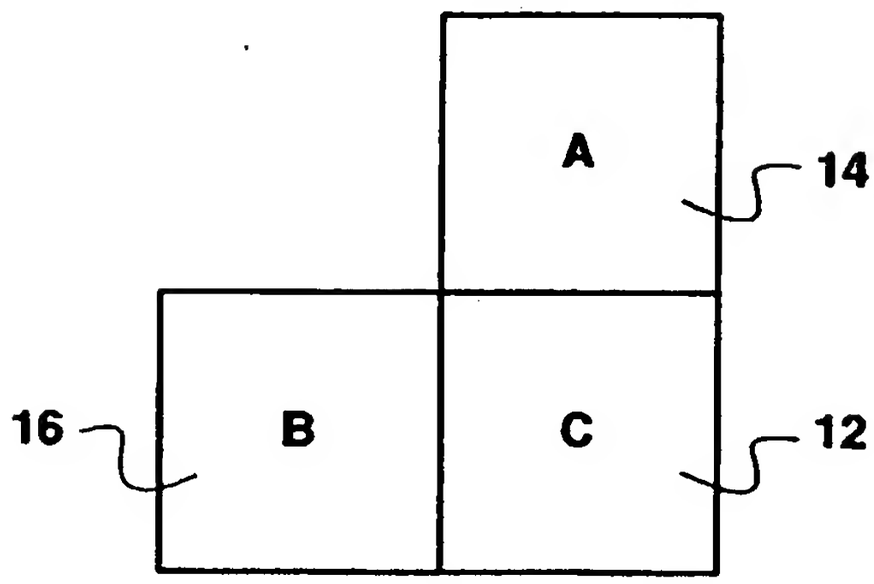
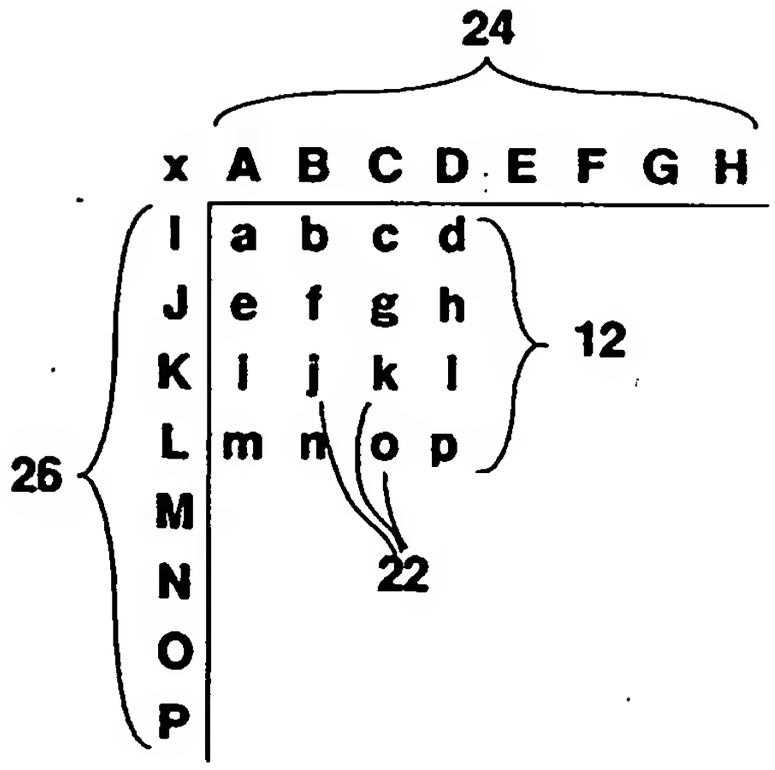

A
14
16
B
C
12

FIG.2


24
x A B C D E F G H
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J e f g h
K I j k l
L m n o p
M
N
O
P
26
12
22

FIG.3

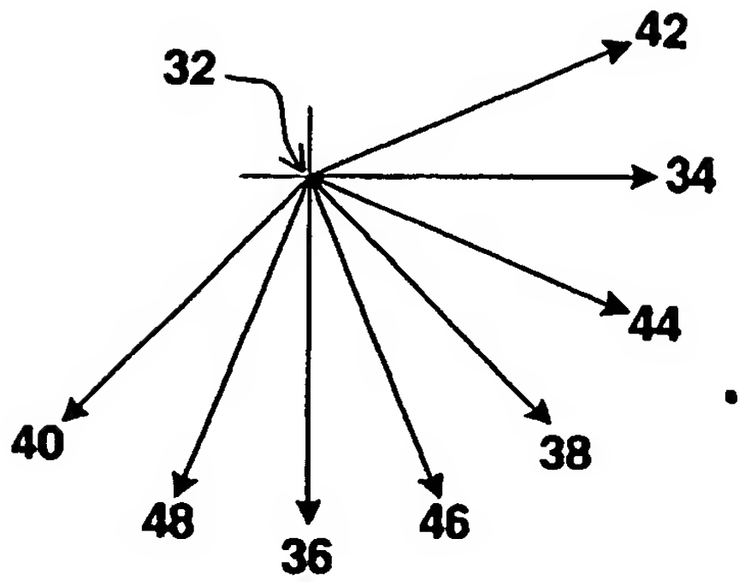

FIG.4

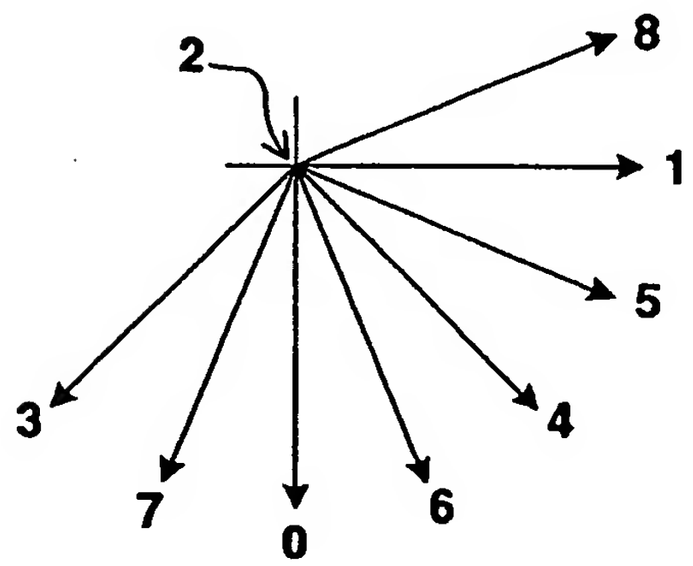

FIG.5

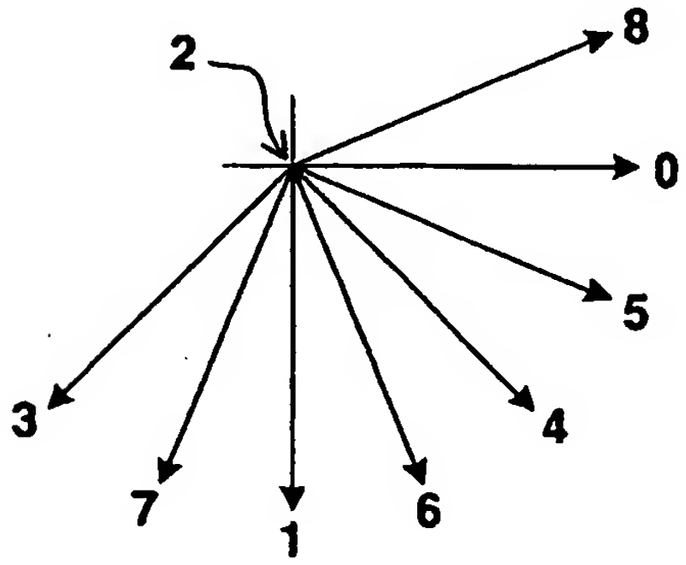

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FIG.6

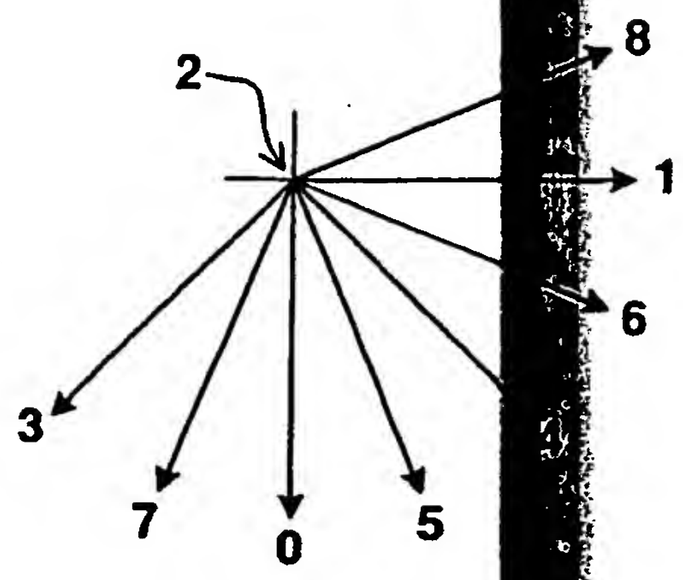


FIG.7

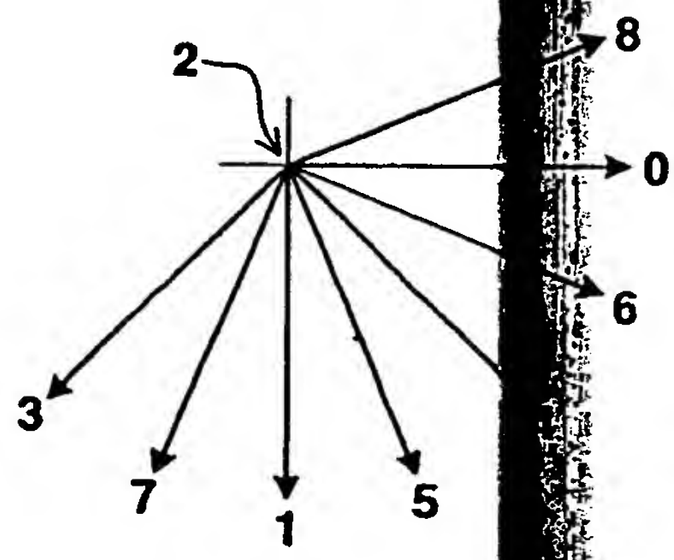


FIG.8

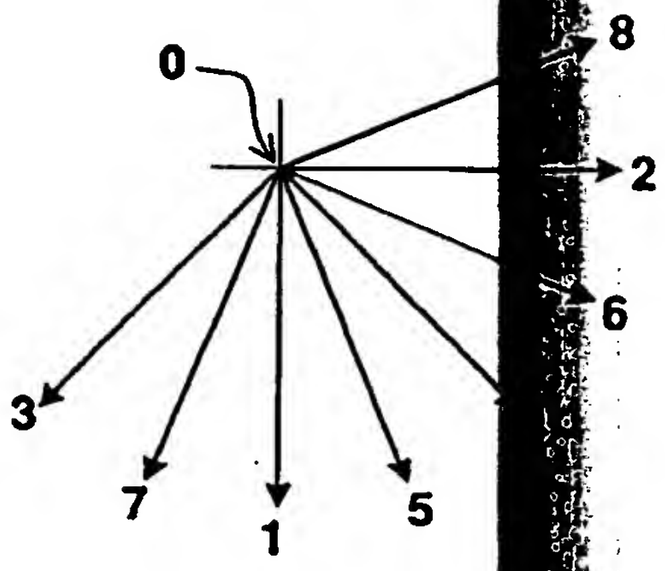


FIG.9

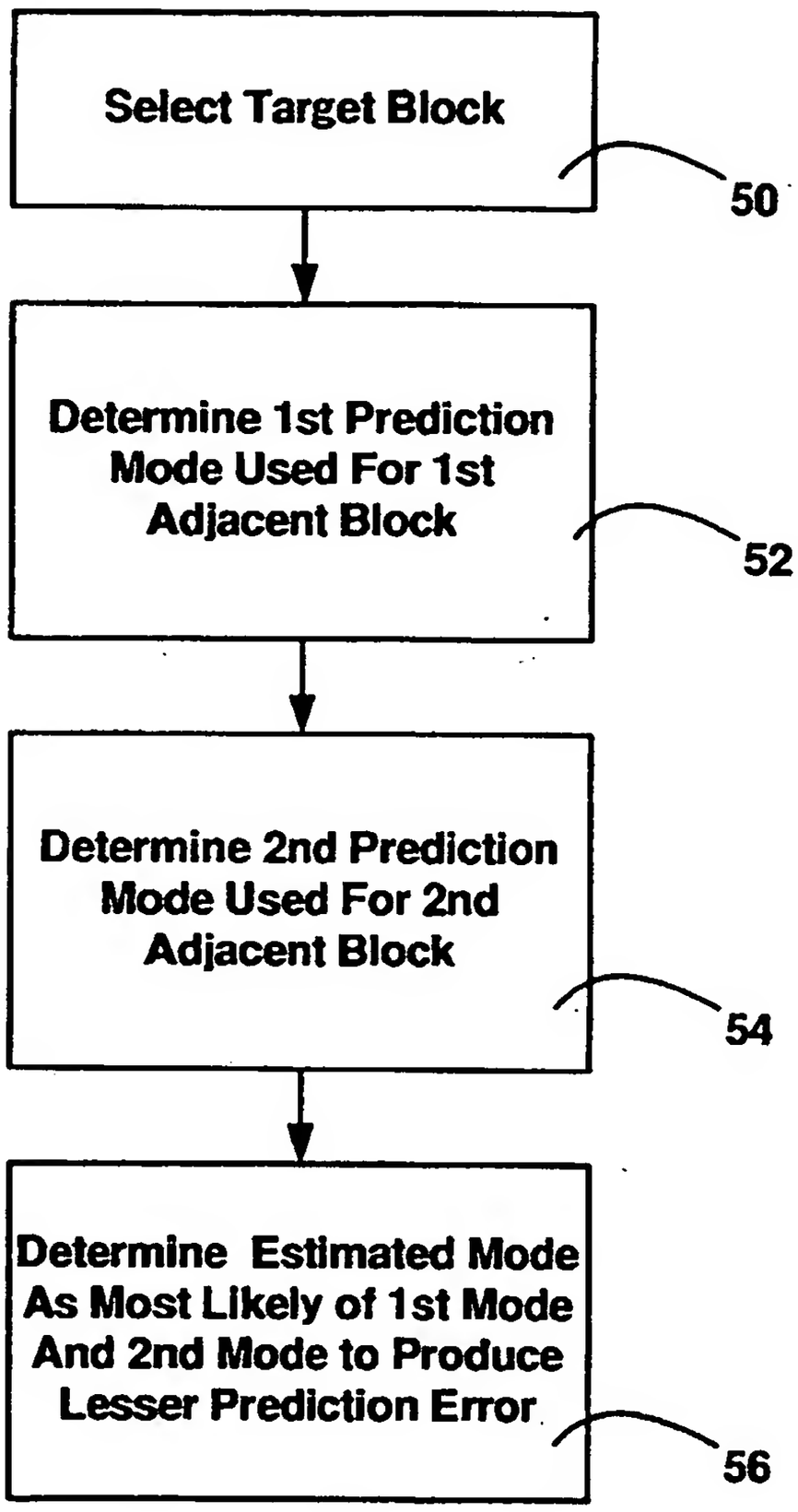

Select Target Block
50
Determine 1st Prediction Mode Used For 1st Adjacent Block
52
Determine 2nd Prediction Mode Used For 2nd Adjacent Block
54
Determine Estimated Mode As Most Likely of 1st Mode And 2nd Mode to Produce Lesser Prediction Error
56

FIG.10

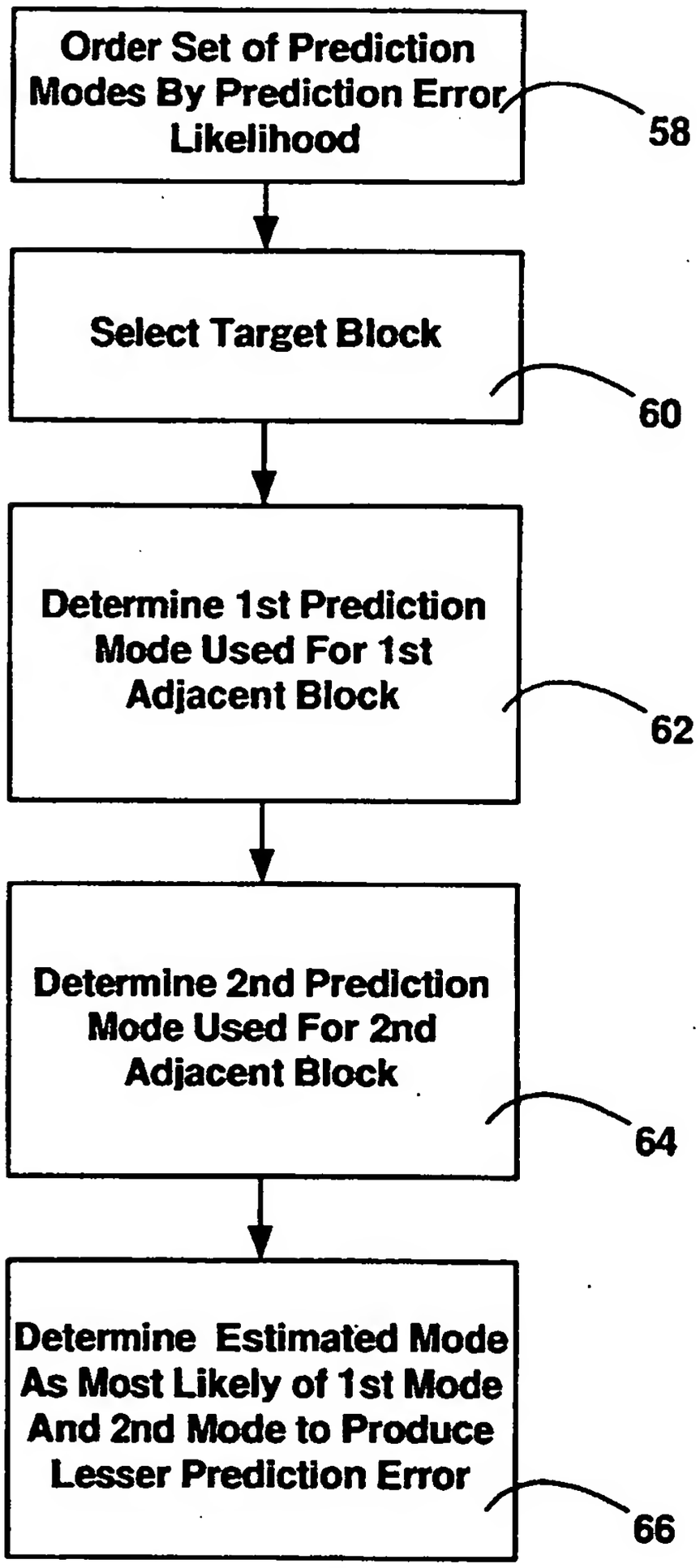

Order Set of Prediction Modes By Prediction Error Likelihood
58
Select Target Block
60
Determine 1st Prediction Mode Used For 1st Adjacent Block
62
Determine 2nd Prediction Mode Used For 2nd Adjacent Block
64
Determine Estimated Mode As Most Likely of 1st Mode And 2nd Mode to Produce Lesser Prediction Error
66

FIG.11

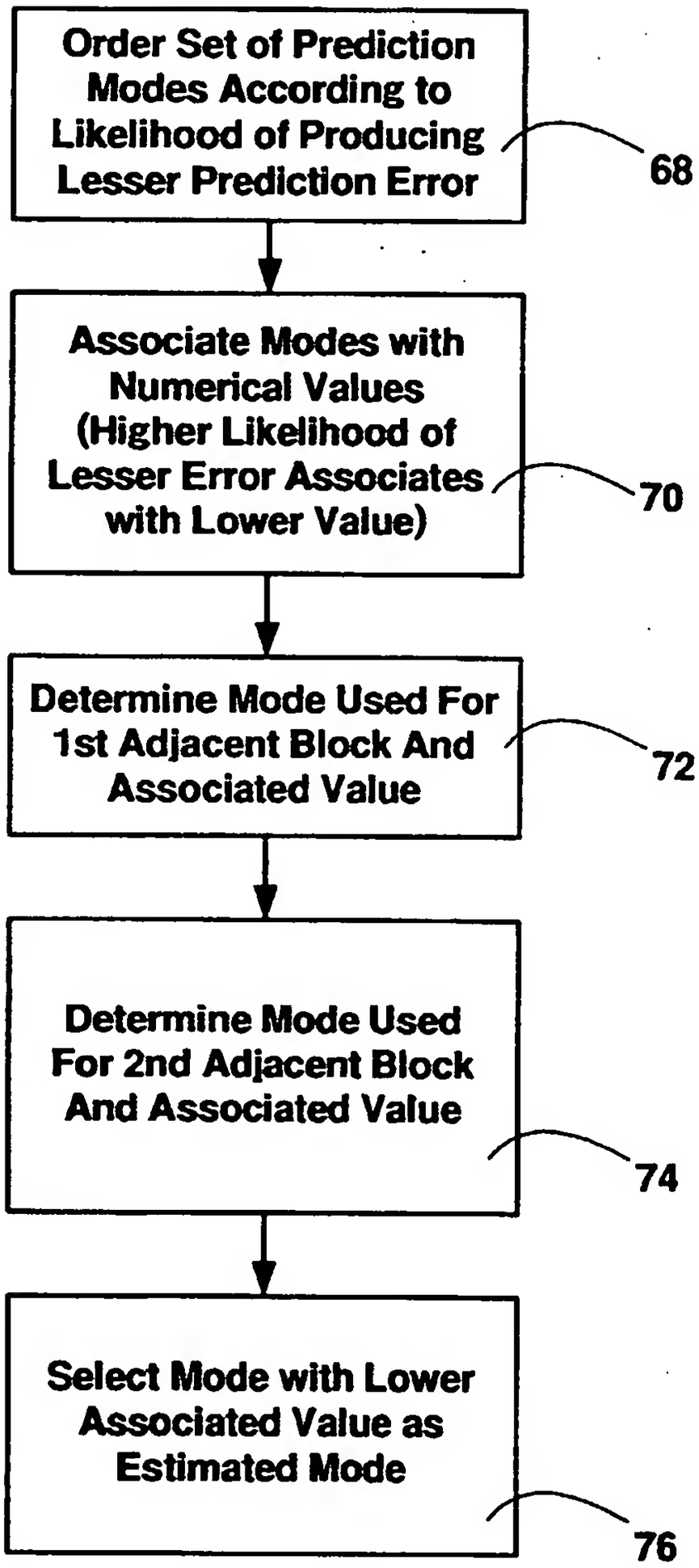

Order Set of Prediction Modes According to Likelihood of Producing Lesser Prediction Error
68
Associate Modes with Numerical Values (Higher Likelihood of Lesser Error Associates with Lower Value)
70
Determine Mode Used For 1st Adjacent Block And Associated Value
72
Determine Mode Used For 2nd Adjacent Block And Associated Value
74
Select Mode with Lower Associated Value as Estimated Mode
76

FIG.12

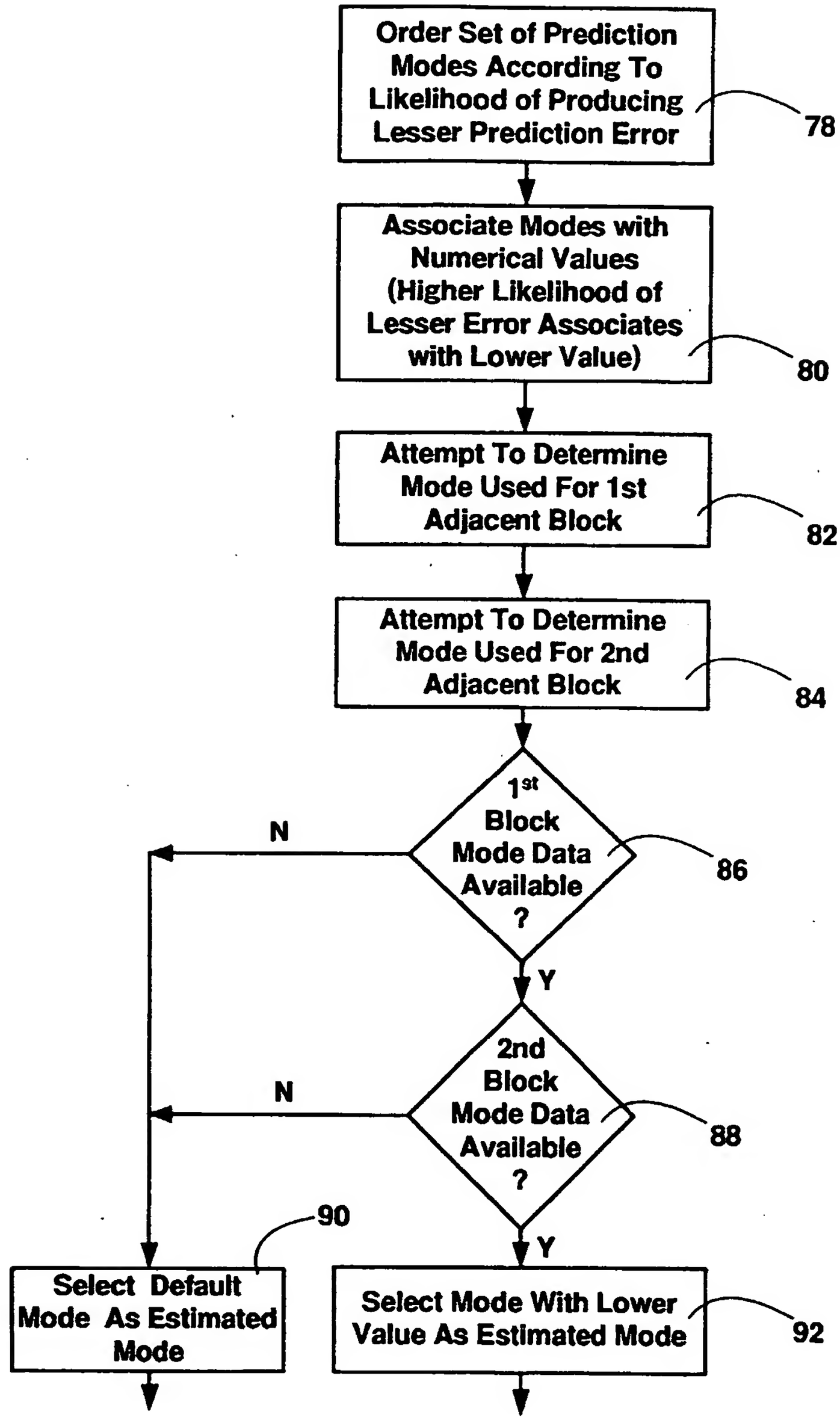

Order Set of Prediction Modes According To Likelihood of Producing Lesser Prediction Error
78
Associate Modes with Numerical Values (Higher Likelihood of Lesser Error Associates with Lower Value)
80
Attempt To Determine Mode Used For 1st Adjacent Block
82
Attempt To Determine Mode Used For 2nd Adjacent Block
84
1st Block Mode Data Available ?
86
N
Y
2nd Block Mode Data Available ?
88
N
Y
Select Default Mode As Estimated Mode
90
Select Mode With Lower Value As Estimated Mode
92

FIG.13

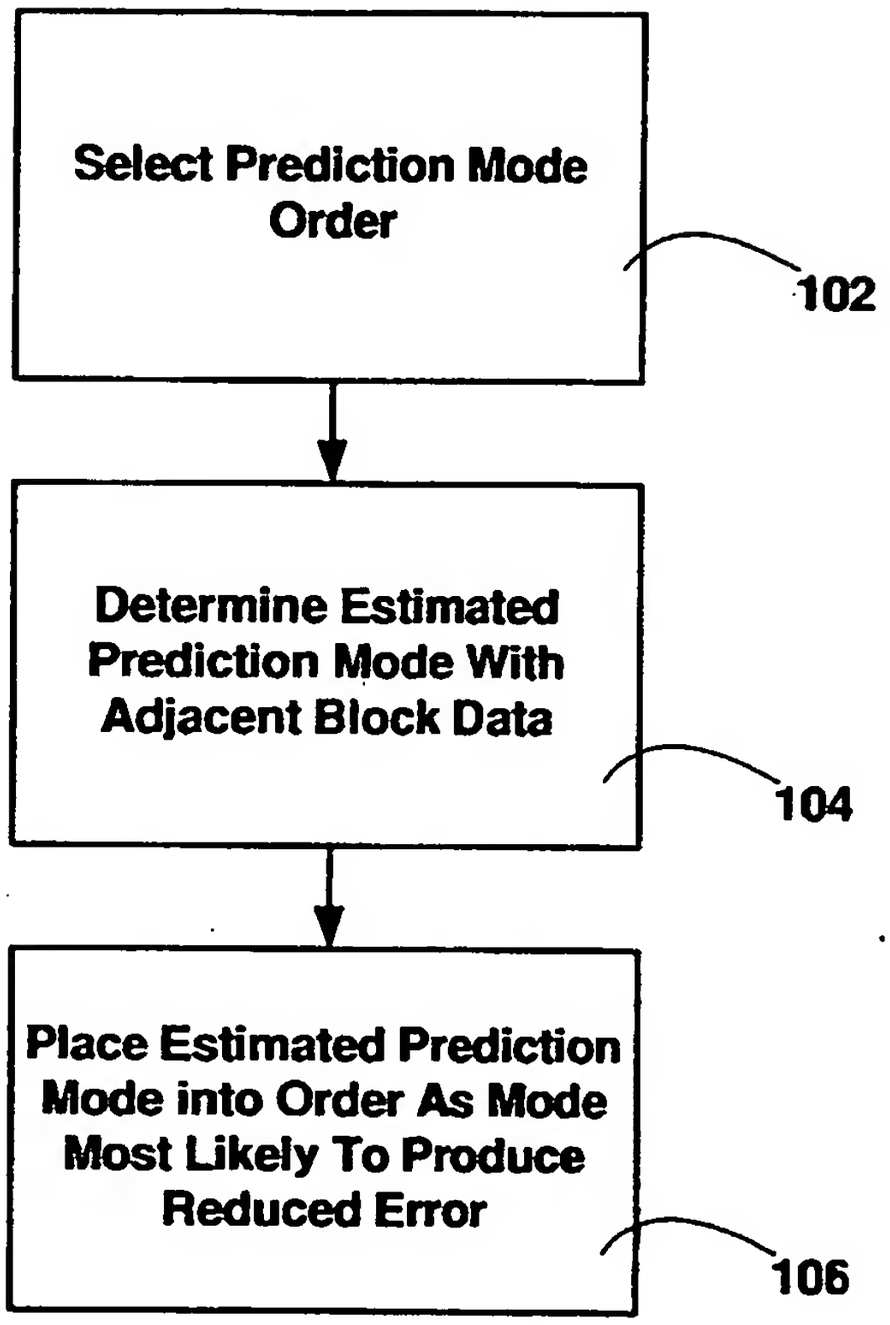
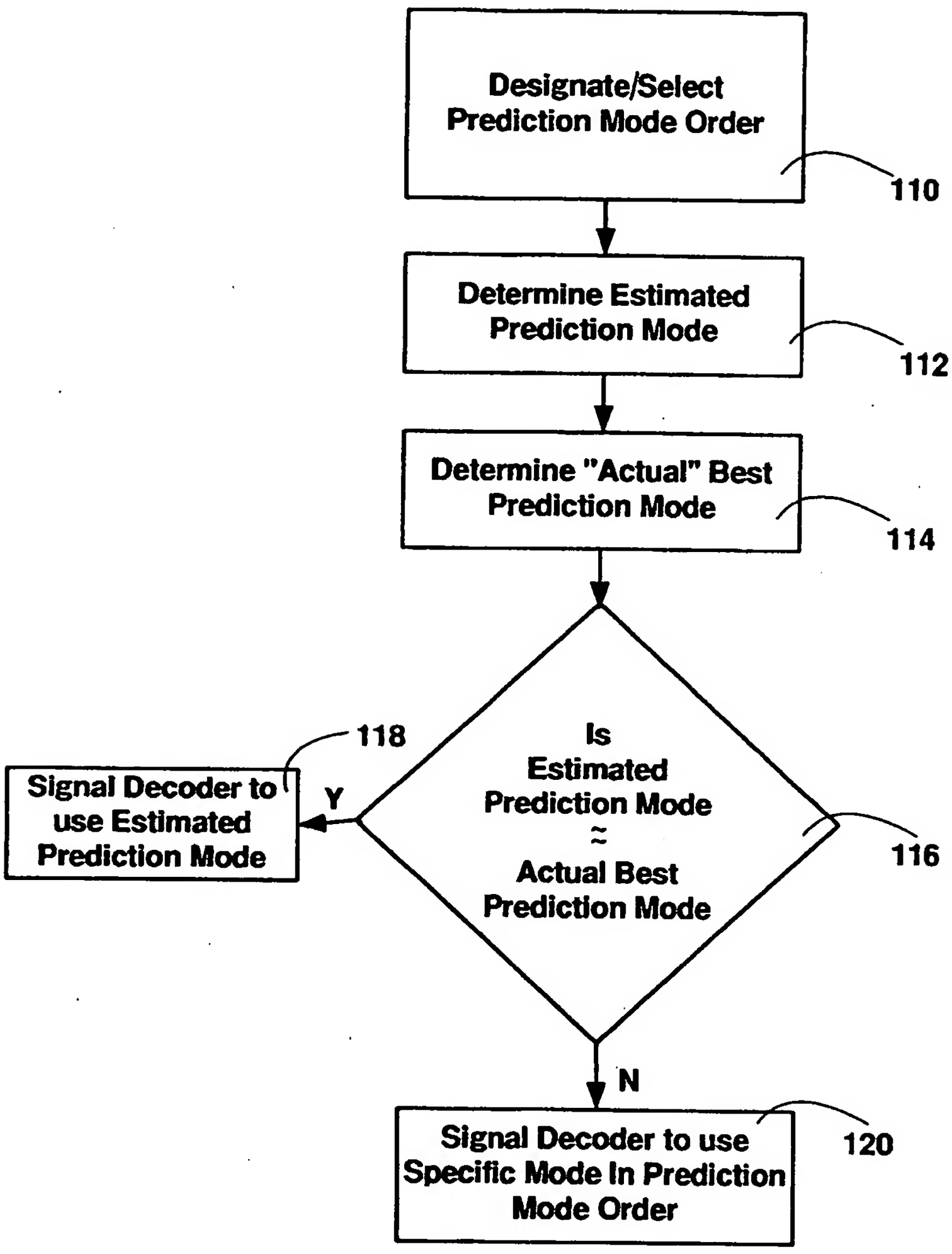
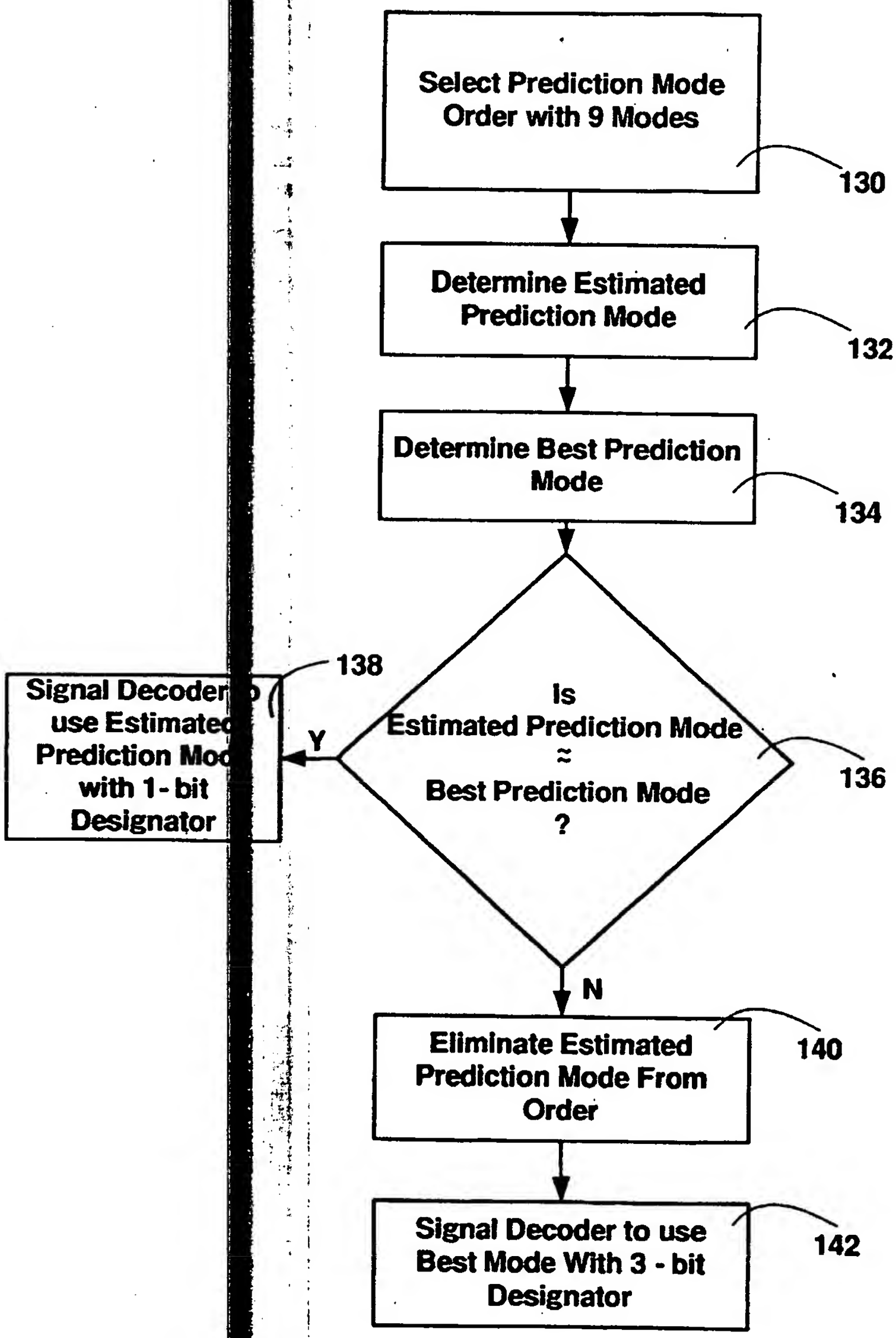

Select Prediction Mode Order
102
Determine Estimated Prediction Mode With Adjacent Block Data
104
Place Estimated Prediction Mode into Order As Mode Most Likely To Produce Reduced Error
106

FIG.14


Designate/Select Prediction Mode Order
110
Determine Estimated Prediction Mode
112
Determine "Actual" Best Prediction Mode
114
Is Estimated Prediction Mode ≈ Actual Best Prediction Mode
116
Y
118
Signal Decoder to use Estimated Prediction Mode
N
Signal Decoder to use Specific Mode In Prediction Mode Order
120

Best Available Copy

FIG.15



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/6623

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl⁷ H04N 7/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl⁷ H04N 7/24-7/68

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Japanese Utility Model Gazette 1926-1996, Japanese Publication of Unexamined Utility Model Applications 1971-2003, Japanese Registered Utility Model Gazette 1994-2003, Japanese Gazette Containing the Utility Model 1996-2003

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	H.26L Test Model Long Term Number 6(TML-6) draft0.[Online], ITU-Telecommunications Standardization Sector STUDY GROUP 16 Video Coding Experts Group(VCEG), 2001. pages 11-14, [retrieved on 2003-05-28], Retrieved from the INTRTNET:<URL:http://kbs.cs.tu-berlin.de/~stewe/vceg/TMLDocs/VCEG-L45d0.doc>	1-54
X	JP 08-186823 A (Canon Co.,Ltd) 1996.07.16, full document & EP 720379 A2 & US 5883976 A1	34,35
X	JP 05-183758 A (International Business Machines Corporation) 1993.07.23, page 5,column7,line43 - column8,line17 & US 5157488 A & CA 2062155 A & EP 513520 A2 & DE 69220541 T	34,35

☑ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22.09.03	14.10.03

Name and mailing address of the ISA/JP	Authorized officer		
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	MICHIHARU SUGAHARA Seal	5P	8725
	Telephone No. +81-3-3581-1101 Ext. 3580		

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/06623

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
T	Iain E G Richardson, "H.264/MPEG-4 Part 10:Intra Prediction", pages 1 of 1 - 7 of 7, [online], 07.10.02, H.264/MPEG-4 Part 10 White Paper, [retrieved on 2003-9-22], Retrieved from the INTERNET:<http://218.30.21.30/sc/jywd/h264_intrapred.pdf>	1-54
T	Iain E G Richardson, "H.264/MPEG-4 part 10 Tutorials", H.264/MPEG-4 Part 10:Intra Prediction pages 1 of 6 - 6 of 6, [online], 30.04.03, vcodex:H.264 tutorial white papers, [retrieved on 2003-9-22], Retrieved from the INTERNET:<http://www.vcodex.fsnet.co.uk/h.264.html>	1-54
T	Bojun Meng, Oscar C. Au, "Fast Intra-Prediction Mode Selection for 4x4 Blocks in H.264", ICASSP 2003 IEEE International conference, (April 6-10,2003), IEEE, pp.III-389 - III-392	1-54